BOOK REVIEWS

# A Quantum Leap

## Computing at the Atomic Level

*by Brian Insolo*

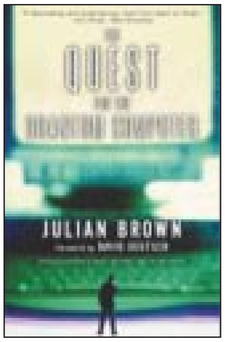
Schedule 76, Publication Media, can help you learn more about information technology and its future with books on quantum computing. Listed are some of the books available on Schedule 76.


**A Shortcut Through Time: The Path to the Quantum Computer**
*George Johnson*
March 2003

*A Shortcut Through Time* explains, in an easy-to-understand way, the logic behind today's computers and how this thinking could ultimately lead to a quantum computer using a single atom that could solve problems that take forever on present-day supercomputers.

In today's computers, information is represented as a series of 1s and 0s in which a switch is either on or off. In a quantum computer, a qubit, a unit of quantum memory, can be a 1, 0, or both at the same time (superposition) since, at the atomic level, atoms spin clockwise and counterclockwise simultaneously. Given the nature of a switch in a quantum computer, much more data could be represented than in today's computers and equations could be solved much quicker. It is also believed that a "shortcut through time" could result when entangled quantum particles are zapped with a laser gun to perform computations on a number of atoms at once.

Moving from theory to practice, the biggest problem with a quantum computer is constructing it. Quantum computing has recently been demonstrated with four qubits, but this "computer" was much less powerful than the current silicon microprocessor that handles billions of bits. In addition, writing software for a quantum computer would be very difficult because of the computer's inflexibility and the complexity of the data it processes. (The complexity of data partially arises from entanglement, the controlled process by which qubits interact while being isolated from the uncontrolled environment outside the computer.) However, in 1994, Shor's algorithm, the "killer app" of quantum computing, allowed a number to be quickly factored into its divisors. Using this algorithm and a quantum computer, the code of encrypted messages could easily be cracked. Paradoxically, as a quantum computer becomes more feasible, the algorithm could improve security as the inadequacies of our current encryption methods are made very clear. Johnson's *A Shortcut Through Time* gives the layman an understanding of the convergence of physics, mathematics, and computing and how a quantum computer could change our understanding of the natural world and cryptography.



**The Quest for the Quantum Computer**
*Julian Brown*
2001

Brown's *The Quest for the Quantum Computer* explains key concepts that form the basis of quantum physics, or how matter behaves at the atomic level, and how these ideas have led scientists to believe a powerful quantum computer may be constructed in the future. Topics discussed include Rolf Landauer's musings on information processing, Charles Bennett's pioneering studies of reversible programs, Paul Benioff's model for a quantum computer based on quantum mechanics, Ed Fredkin's and Richard Feynman's investigations into a completely reversible computer in which no energy is wasted, and David Deutsch's theories on alternate universes.

*The Quest for the Quantum Computer* speculates that in addition to enriching our understanding of cryptography, a quantum computer would help us learn about the natural world through sophisticated models of nuclear reactions and could lead to insights into time travel. Brown also believes that a quantum computer could help us to visualize a world in which multiple realities occur and to design more effective medications. *The Quest for the Quantum Computer* uses numerous diagrams to explain this mind stretching topic, and the book is highly recommended for those who enjoy scientific works and want to know the direction in which technology is heading in the future.

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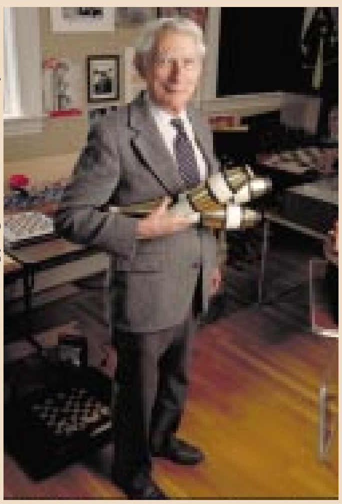

Dr. Claude Shannon, an American mathematician and computer scientist, created theories that helped develop electronic communications networks. His early work included papers that discussed the potential of binary digits, or 1s and 0s, to encode information as well as artificial intelligence (AI) experiments such as chess-playing machines and an electronic mouse, Theseus, who ran a maze.

While at M.I.T., from which Dr. Shannon received a master's degree in electrical engineering and a Ph.D. in mathematics in 1940, he worked with a colleague on an early computer called a "differential analyzer". Dr. Shannon's master's thesis, "A Symbolic Analysis of Relay and Switching Circuits," described how Boolean logic, in which binary digits were used to solve problems, could be done automatically with electrical circuits. The thesis has been described as one of the most important master's theses ever written.

After graduating from M.I.T., Dr. Shannon went to work at AT&T Bell Laboratories in New Jersey and in 1948 he published his masterpiece, "A Mathematical Theory of Communication." This work produced the field of information science and discussed sending messages as binary code rather than electromagnetic waveforms, as was common at the time. The importance of this work led to the thinking that all messages, whether they were words, video, or music, could be dealt with in the same way since all were composed of binary digits. In addition, this work has the first published usage of the word "bit" (as it related to computers).

In 1958, Dr. Shannon returned to M.I.T. and remained there for two decades. In his retirement, he programmed a computer to beat roulette, played the stock market using probability theory, and studied the mathematical theory of juggling. (Juggling was a hobby that interested Dr. Shannon throughout his life.)

Sadly, on February 24, 2001, Dr. Shannon passed away at age 84. However, the importance of his work endures in numerous fields including cryptography, biology, and investment theory. (The importance of his work in such diverse fields caused Dr. Shannon to lament in later years this "bandwagon effect" and to comment, "Information theory has perhaps ballooned to an importance beyond its actual accomplishments.")

*Source:*
Johnson, George. "Claude Shannon, Mathematician, Dies at 84." New York Times, 27 February 2001.